

Body weight, sex and age factors in a population of the Northern Palm Squirrel, *Funambulus pennanti* Wroughton

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(With six text-figures)

This paper presents a study of the Northern Palm Squirrel, *Funambulus pennanti* Wroughton at Jodhpur in Western India. The study area was a garden. Traps were generally placed where they were likely to catch more squirrels instead of in a grid system. Their positions were noted by numbering the trees, near the bases of which they were placed. A total of 213 squirrels were captured, marked and released for further observations. Marking was done by toe and ear clipping. Observations were made on body weight, sex ratio, age structure, and persistence.

INTRODUCTION

The palm squirrels of the genus *Funambulus* are familiar rodents living in association with man. They are arboreal, diurnal, and comparatively easy to trap. However, not much information is available on the population structure of this rodent. This paper gives data on the body weight, sex composition, age structure and variations in the squirrel population of a localised habitat at Jodhpur. Persistence of marked squirrels in the study area is also discussed.

STUDY AREA

Jodhpur has four distinct seasons : Winter (December to February), Summer (March to June), Monsoon (July to September) and Post-monsoon (October and November). The mean maximum temperature at Jodhpur is 25.9°C and the mean minimum 10.4°C during Winter, 37.9°C and 23.1°C in Summer, 34.6°C and 23.3°C during Monsoon ; and 33.1°C and 15.8°C during Post-monsoon respectively. The rainfall is almost confined to the monsoon season with a few showers occurring during winter. The average annual rainfall is 366 mm. There was

scanty rainfall (178.6 mm.) during 1963 and drought conditions prevailed from September, 1963 to June, 1964. The rainfall recorded during 1964 was 539.3 mm.

The local habitat was a small garden, 1.16 hectare in area. There were 36 trees in this area belonging to the species : *Azadirachta indica* A. Juss.; *Phoenix sylvestris* Roxb.; *Ficus religiosa* Linn.; *Mangifera indica* Linn.; *Albizia lebbek* Benth.; *Saraca indica* Linn. etc. Hedges of *Dodonea viscosa* Linn., *Tecoma stans* (Linn.) H.B.K., and shrub species like *Jasminum sambac* Ait., *Jasminum auriculatum* Vahl., *Hibiscus rosa-sinensis* Linn. and *Bougainvillea spectabilis* Willd. *Cynodon dactylon* Pers. was the dominant grass.

METHODS

The study period was from April, 1963 to 15th November, 1964. The habitat was divided into three blocks and trapping was done with 15 traps on two days in a week in each block. However, only 12 traps were used during May and June, 1964. Since some traps always remained unoccupied, use of only 12 traps during these months did not affect the trapping. As the squirrel is arboreal, traps were placed near the base of the trees which were numbered. Placing the traps in a grid system over the area would have resulted in the capture of very few squirrels due to continuous disturbance from stray dogs and by personnel working in the area.

The squirrels caught were sexed, weighed and marked by toe clipping (Layne 1954). Squirrels up to number 198 were marked by this method and the rest with a combination of toe and ear clipping as it was felt undesirable to cut more than two toes from the foot. Marked squirrels were again released. The capture points were noted for the study of home ranges. Ten female squirrels, suspected to be pregnant, were retained in the laboratory during the course of the study for investigating litter size and post-natal development. Out of these ten, two died and three delivered. All the surviving animals that were retained in the laboratory were subsequently released.

OBSERVATIONS AND DISCUSSION

Body weight

During the period December, 1963 to March, 1964, new squirrels were not captured and, therefore, body weights of new squirrels could not be taken during these months. The individual weights of the squirrels handled varied from 28.0 to 129.0 gm. (Figs. 1 and 2). Mean monthly body weights and number of freshly captured squirrels weighed in every

month are given in Table 1. The differences in mean body weight of male and female squirrels are not significant. However, the body

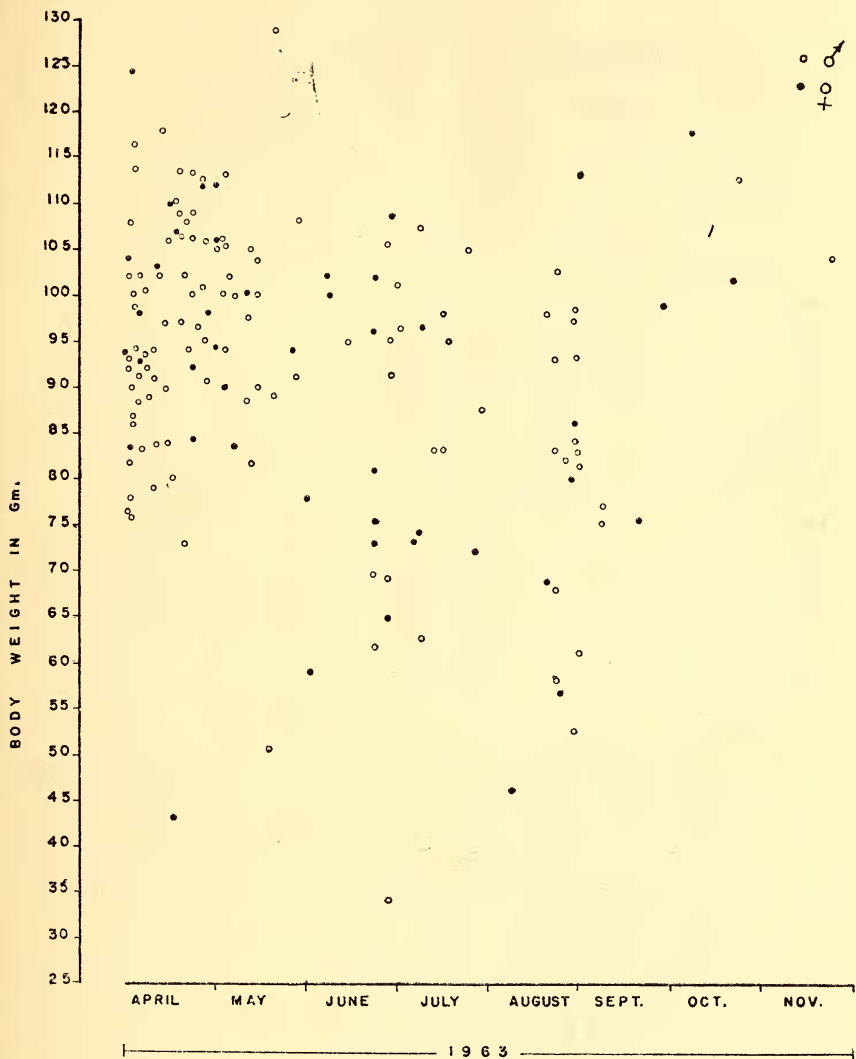


FIG. 1. Body weights of freshly captured squirrels during April to November, 1963.

weight is higher in April and May, 1963, as compared to other months. There is a gradual decrease in the body weight after these months. The weight again increases in October. Almost a similar trend was observed in the 1964 population, particularly among males. The decrease during June, July and August may be due to the presence of younger rodents in the population as this period is the main breeding season (Purohit,

Kametkar & Prakash 1966) and, therefore, weight differences between individuals are high (Figs. 1 and 2).

TABLE 1
MEAN MONTHLY BODY WEIGHTS WITH STANDARD ERROR (SE) AND
NUMBER OF FRESHLY CAPTURED SQUIRRELS

Months	Male		Female	
	No. weighed	Mean body weight (gm.) \pm SE	No. weighed	Mean body weight (gm.) \pm SE
1963				
April	51	96.08 \pm 1.8	13	96.44 \pm 4.29
May	18	98.0 \pm 3.69	5	91.20 \pm 2.82
June	8	77.28 \pm 8.42	11	85.45 \pm 5.09
July	11	89.77 \pm 4.34	4	78.87 \pm 5.89
August	15	82.32 \pm 4.32	6	75.0 \pm 9.39
September	2	76.0 \pm 1.0	2	77.25 \pm 1.73
October	1	112.5	2	109.75 \pm 8.72
November	1	104.0	—	—
1964				
April	8	96.12 \pm 0.30	3	93.3 \pm 2.76
May	8	71.25 \pm 11.1	4	89.25 \pm 24.38
June	8	73.93 \pm 7.46	5	76.40 \pm 10.34
July	8	77.0 \pm 11.49	1	103.5
August	4	60.0 \pm 9.49	3	77.33 \pm 7.61
September	2	87.5 \pm 2.55	—	—
October	2	92.0 \pm 9.37	2	71.5 \pm 21.36
November	0		0	

To examine these differences, squirrel weights were grouped at 20 gm. intervals. The 30.1-70 gm. classes correspond to sub-adults (Purohit 1963) and the rest to adults (Table 2). The sub-adult animals (5.5%) were observed in April among females of 1963 and in May among males (5.5%). In this year the population of the 30.1 to 50.0 gm. weight class rodents is low. During 1964, when drought conditions prevailed, the sub-adult classes appeared in the population in both sexes in May, a month later than the females of 1963. This may be an indication that breeding was delayed by one month in 1964. The second noteworthy point is the larger representation of 30.1 to 50 gm. weight class among the 1964 population (Table 2), particularly among males, which shows that the emergence of young squirrels, and their weights at emergence differed during years. During 1964, the mother squirrels were not probably in a position to continue providing sufficient milk for their litter as they were in poor condition after the prolonged heat stress although there was enough water and vegetation. Therefore, relatively younger (and lighter) individuals were forced to venture out of their nests in quest of food. A very young squirrel weighing 28 gm. was captured in July, 1964.

TABLE 2

MONTHLY DISTRIBUTION OF VARIOUS WEIGHT CLASSES OF PALM SQUIRRELS EXPRESSED AS PER CENT OF MONTHLY COLLECTION OF BOTH SEXES

Weight class gms.	1963											1964				
	April	May	June	July	Aug.	Sept.	Oct.	Nov.	April	May	June	July	Aug.	Sept.	Oct.	
	Male population															
30·1-50·0	..	00	00	12·5	00	00	00	00	00	43	12·5	14·3*	25	00	00	
50·1-70·0	..	00	5·5	37·5	18·1	26·6	00	00	00	00	37·5	28·5	25	00	00	
70·1-90·0	..	26	16·6	00	27·2	33·3	100	00	00	25	12·5	00	50	100	50	
90·1-110·0	..	66	66·6	50·0	54·6	40·0	00	00	100	75	37·5	28·5	00	00	50	
110·1-130·0	..	8	11	00	00	00	00	100	00	00	00	28·5	00	00	00	
	Female population															
30·1-50·0	..	5·5	00	00	00	16·6	00	00	00	25	00	00	00	00	00	
50·1-70·0	..	00	00	18·1	00	33·3	00	00	00	00	60	00	33·3	00	50	
70·1-90·0	..	16·6	60	36·3	75	33·3	50	00	00	66·6	00	00	66·6	00	00	
90·1-110·0	..	61·1	40	45·4	25	00	50	00	00	25	40	100	00	00	50	
110·1-130·0	..	16·6	00	00	00	16·6	00	50	00	33·3	50	00	00	00	00	

* One sub-adult squirrel weighed 28 gm.

A majority of the squirrel population falls in the 70.1 to 100.0 gm. class. A heavier weight class (110.1-130.0 gm.) was observed during 1963, in April and May in the males and in April only among the females.

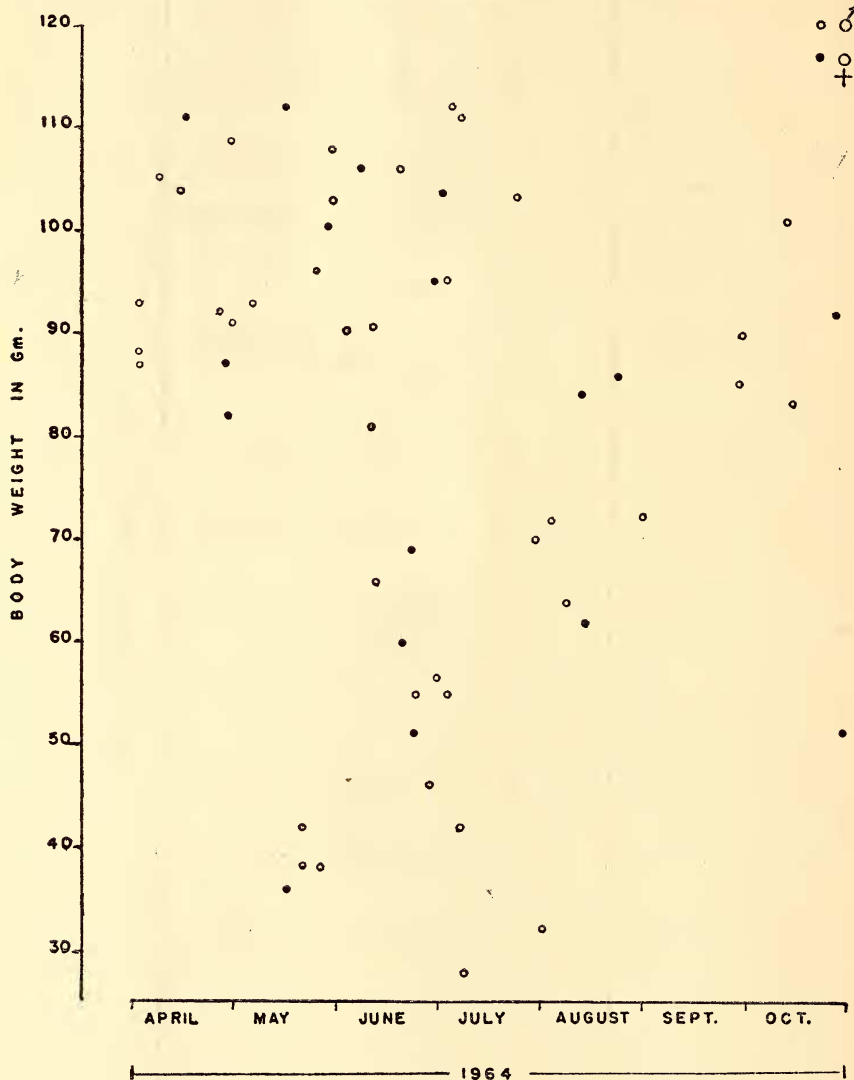


FIG. 2. Body weights of freshly captured squirrels during April to October, 1964.

In both sexes it reappeared in October but was also present in August in the females which might be due to the presence of pregnant females as breeding activity is maximum during the monsoon season. During 1964, however, this class occurred only in July in the male population and during April and May in female population but it was totally absent

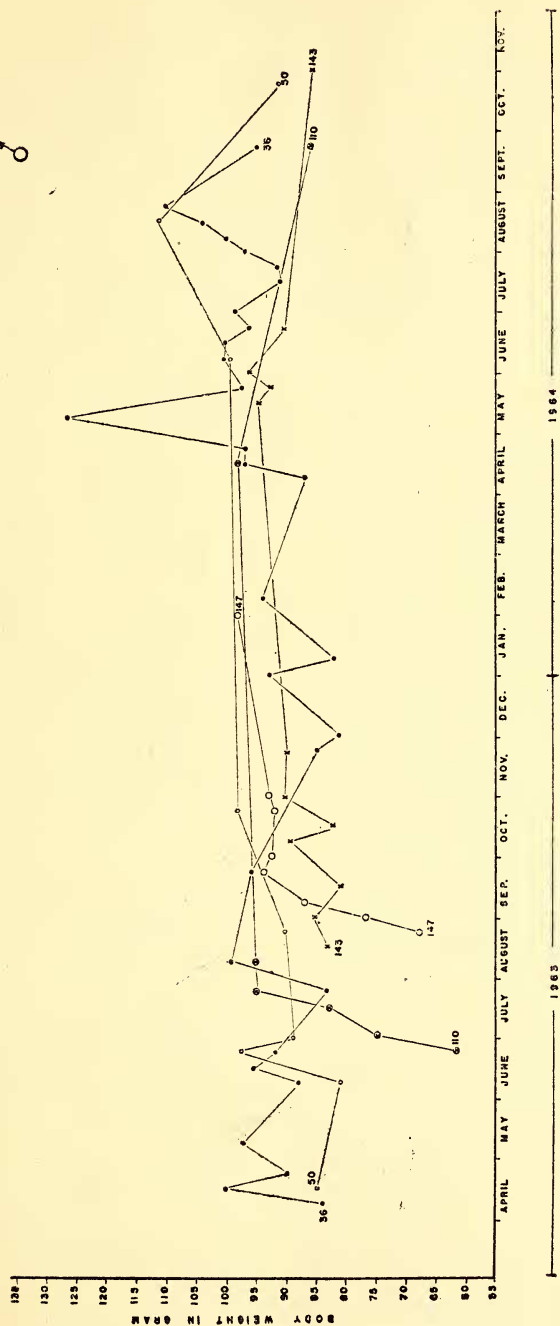


FIG. 3. Body weights of five male squirrels trapped repeatedly during the course of study.

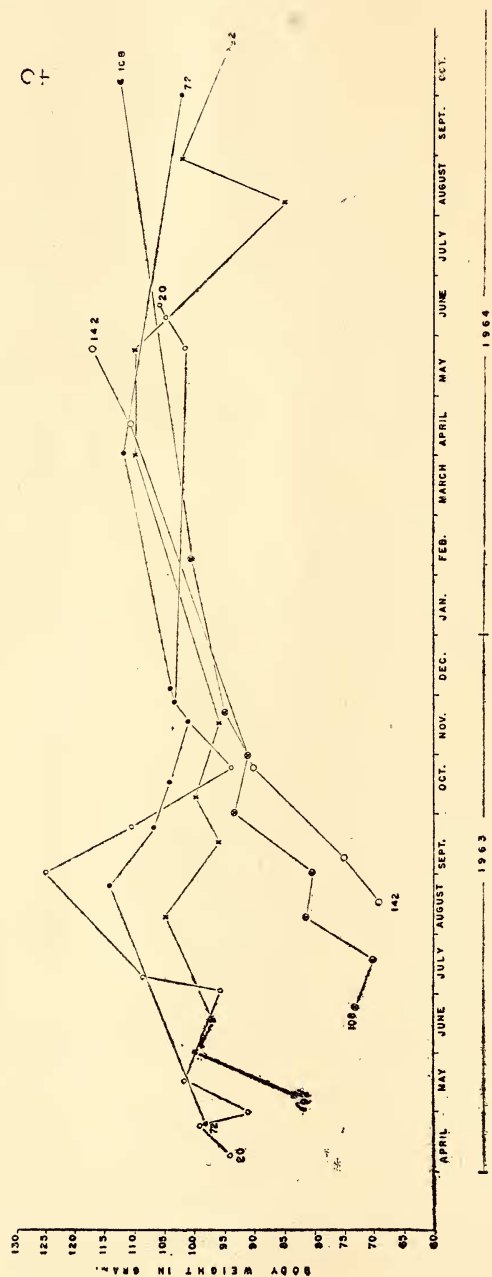


Fig. 4. Body weights of five female squirrels trapped repeatedly during the course of study.

in the latter months in the male population. This difference in the two seasons may be an indication that the old animals were either eliminated due to heat stress when living conditions were not very favourable or they migrated from this habitat.

Body weights of individual squirrels which were captured many times during the study period have been plotted (Figs. 3 and 4) to examine the seasonal fluctuations. It will be seen that in most of the males (Fig. 3) the body weights have peaks during monsoon in both the years. Squirrel No. 36, however, had a major peak in May, 1964. Males showed a general decline in body weight during the summer months and post-monsoon season although there are indications of higher monthly weights in the entire population during this period (Table 1). The females also showed peaks in body weight in the monsoon season during 1963 (Fig. 4). Unfortunately these squirrels did not visit the traps in the 1964 rainy season and it is difficult to compare the trend of their weights with that of 1963 although squirrel No. 92 showed a decrease in body weight in this season. These five females also showed a decline in body weight during summer 1963, such decline is also indicated by the body weight figures presented in Table 1.

Sex ratio

During the entire study 213 squirrels were collected, out of which 147 were males and 66 females which shows that there is a general preponderance [69%, significantly different from 50% ($\chi^2(1)$ 30.8 $P < .001$)] of males in the population. The females were 57.9 and 66.0 per cent of the monthly captures during June and October, 1963, respectively (Table 3). These values are not significantly different from 50 per cent. During

TABLE 3

SEX RATIO OF SQUIRRELS CAPTURED DURING APRIL TO NOVEMBER, 1963 AND FROM APRIL TO OCTOBER, 1964

Months	1963			1964		
	Male	Female	% Male	Male	Female	% Male
April	51	18	73.9	8	3	72.7
May	18	5	78.2	8	4	66.6
June	8	11	42.1	8	5	61.5
July	11	4	73.3	8	1	88.8
August	15	6	71.4	4	3	57.1
September	2	2	50.0	2	0	—
October	1	2	33.3	2	2	50.0
November	1	0	—	—	—	—
	107	48	69.0	40	18	68.9

September, 1963 and October, 1964, both sexes were trapped in equal numbers. The sex ratios remained identical in the year 1963 (2.22 ♂♂ : 1 ♀) and 1964 (2.22 ♂♂ : 1 ♀).

The preponderance of males was also observed in sub-adult *Funambulus pennanti*. During 1963, 11 male and 6 female sub-adults were collected having a ratio of 1.83 ♂♂ : 1 ♀ but during 1964 this ratio was 2.33 ♂♂ : 1 ♀ (Table 4). A slightly greater number of males has been

TABLE 4

SEX RATIO OF SUB-ADULT SQUIRRELS DURING APRIL TO OCTOBER, 1963 AND 1964

Months	1963			1964		
	Male	Female	% Male	Male	Female	% Male
April	0	1	No Male collected	0	0	—
May	1	0	No female collected	4	1	80
June	4	2	66.6	4	3	57.1
July	2	0	No female collected	4	0	No female collected
August	4	3	57.1	2	1	66.6
September	0	0	—	0	0	—
October	0	0	—	0	0	—
	11	6	64.7	14	5	73.7

observed in the Red Squirrel, *Tamiasciurus hudsonicus locuax* in Central New York by Layne (1954) who found 102 males to 100 females in the overall population as compared to 227.7 males : 100 females in *F. pennanti*. Among the sub-adults, however, he recorded 188 males to 100 females as compared to 208.3 sub-adult males for 100 sub-adult females among palm squirrels. Among other species of North American squirrels, Allen (1942) noted a preponderance of females (66%) in the Fox Squirrel, *Sciurus niger rufiventer* at Michigan. Evans & Holdenried (1943) and Fitch (1948) also found greater number of females in the population of Beechy Ground Squirrel, *Citellus beecheyi* in California.

Age structure

In the absence of any work on age determination in the palm squirrel, the observations of Purohit (1963) were taken into account for classifying the squirrel population in two major groups—sub-adults and adults. Squirrels weighing above 70 gm. were found to be sexually active, hence in this paper, squirrels weighing 70 gm. or below are regarded to be sub-adults. The adult to sub-adult ratio in males of 1963 was 8.7 : 1 and of

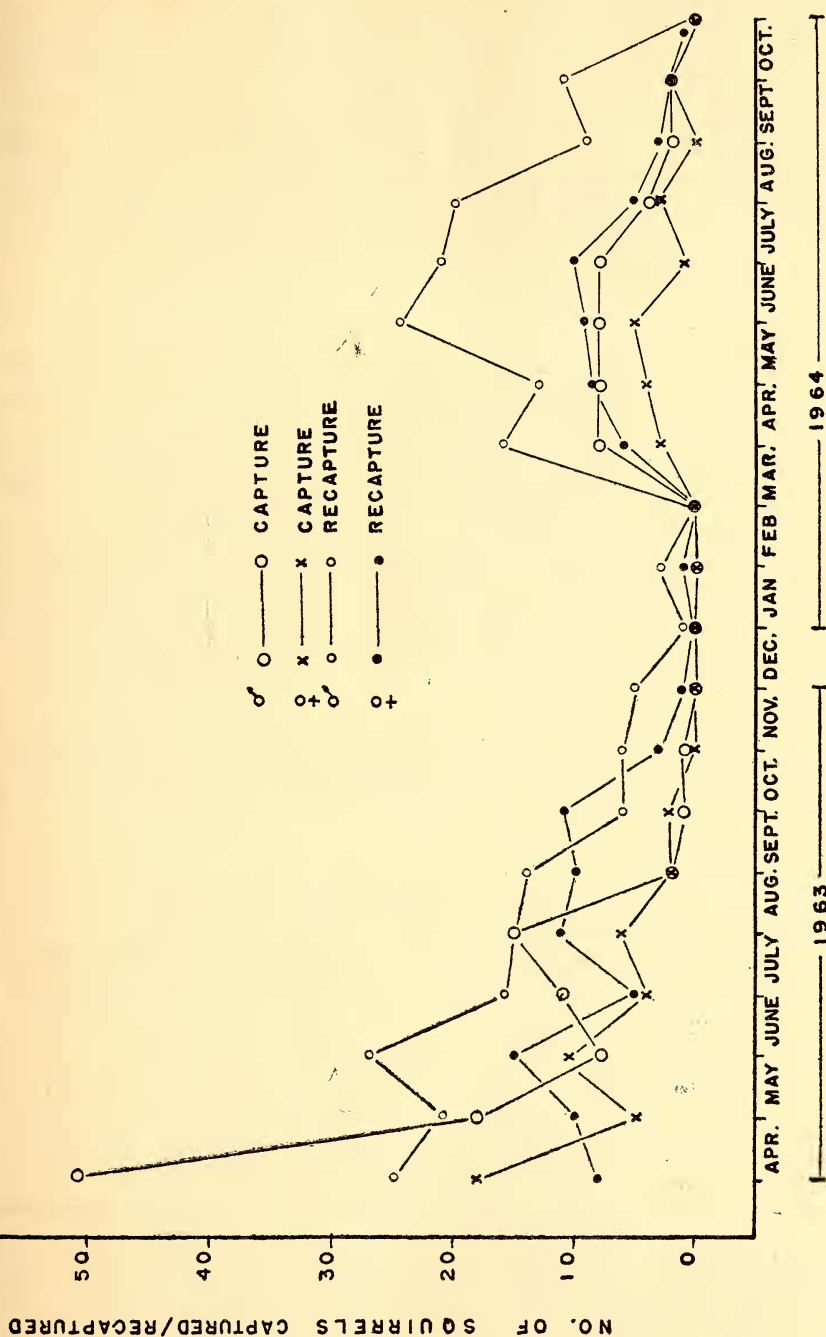


FIG. 5. The number of male and female squirrels captured and recaptured during the study.

adult females to sub-adult females 7 : 1 whereas this ratio showed a considerable change in the 1964 population and was 1·8 : 1 and 2 : 1 respectively. This shows that the number of adult squirrels were reduced to a very great extent in the 1964 population. The rainfall data show that the monsoon failed in 1963 and conditions of heat stress prevailed from September, 1963 to June, 1964. During this period the older generation of squirrels either perished or migrated out of the study area. Such variations in the squirrel numbers during two consecutive years have also been noticed by Allen (1942) in the Fox Squirrel *Sciurus niger rufiventer* at Michigan.

Trapping results

Capture : Figure 5 indicates that the maximum number of squirrels were collected in the first month of the study period after which a gradual decline (small peaks were noticed in June and August) in the captured rodents was observed till November, 1963. Subsequently, from December, 1963 to March, 1964, no new individual was captured. These capture results indicate that the squirrels were more attracted to the traps with bait in summer months as compared to winter months. An almost similar trend was observed from April to November, 1964, when the study came to an end in November due to shifting of the Institute to its own building. The absence of new captures during winter may also be due to the cold spell when squirrels are likely to become torpid.

Recapture: Table 5 (a) and (b) indicate that the percentages of females recaptured during the two years under study varied (79·1% in 1963 and

TABLE 5 (a)
NUMBER OF SQUIRRELS CAPTURED AND RECAPTURED
DURING APRIL, 1963 TO OCTOBER, 1964 PERIOD

Year	Total marked			Total recaptured			Total not recaptured			
	♂	♀	♂♀	♂	♀	♂♀	♂	♀	♂♀	
1963	..	107	48	155	78	38	116	29	10	39
1964	..	40	18	58	29	8	37	11	10	21
1963-64	..	147	66	213	107	46	153	40	20	60

44·4% in 1964). The recapture percentages of males, however, were almost similar in both the years. The trap shyness of the marked female squirrels during the second year is difficult to explain.

The recapture rate was in conformity with the capture rate, being highest in summer and lowest in winter indicating that there was a

seasonal variation in their behaviour towards traps. In winter months, moreover, unmarked and marked squirrels did not behave alike towards

TABLE 5 (b)

PERCENTAGE OF RECAPTURED SQUIRRELS DURING
APRIL, 1963 TO OCTOBER, 1964 PERIOD

Year	Per cent recaptured		
	♂	♀	♂♀
1963 ..	72.9	79.1	74.8
1964 ..	72.5	44.4	63.7
1963-64 ..	72.7	69.6	71.8

the traps when no fresh squirrels were trapped but marked ones which were familiar with them continued to visit the traps.

Variations in squirrel population: Results in Table 6 indicate that the number of squirrels trapped varied between months and between years. The peaks were, however, observed in April, June and August, 1963 and April, June and October, 1964.

TABLE 6

NUMBER OF SQUIRRELS IN THE STUDY AREA DURING VARIOUS MONTHS

Months	Number of squirrels trapped
1963	
April ..	102
May ..	54
June ..	61
July ..	36
August ..	47
September ..	28
October ..	30
November ..	10
December ..	6
1964	
January ..	1
February ..	4
March ..	No catch
April ..	33
May ..	33
June ..	46
July ..	60
August ..	32
September ..	18
October ..	17

Persistence of marked squirrels : Tables 7 and 8 present the number of retrapped squirrels according to the month of first capture and the last recapture. It is possible to calculate the number of squirrels persisting in the study area in any month if we assume that a squirrel remains continuously in the study area between its first and last capture regardless of the pattern of captures in between. It is logical that the squirrels captured for the last time disappear from the study area after the month of last capture. The rest—which have been recaptured in subsequent months—continue to persist in that month. These numbers are plotted as percentage of total number of retrapped squirrels in Figure 6 which

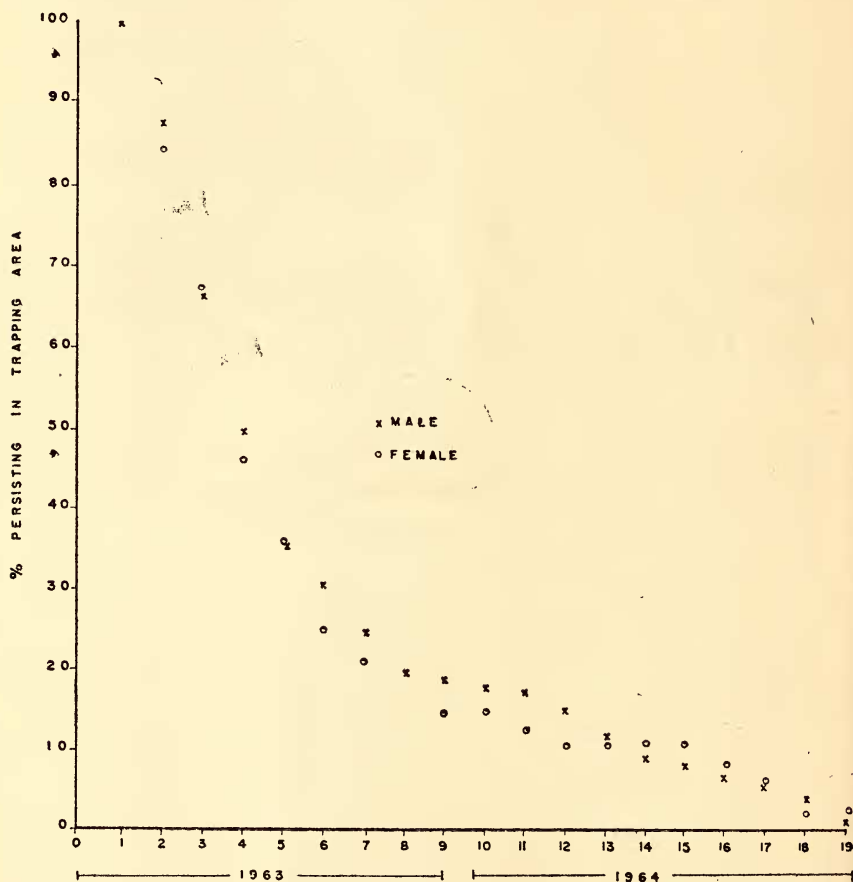


FIG. 6. Per cent marked male and female squirrels persisting in the study area since the month of first capture.

shows that persistence of both the sexes of squirrel dropped down rapidly up to the eighth month when only 19 per cent male as well as female *F. pennanti* persisted in the population. Thereafter the persistence reduced at a lower rate till the last month of the study period when only two

TABLE 7

INTERVAL BETWEEN FIRST CAPTURE AND LAST RECAPTURE OF MARKED FEMALE SQUIRRELS (IN THE COLUMN OF MONTHS OF FIRST CAPTURE, NUMBER OF SQUIRRELS WHICH WERE MARKED IN THAT MONTH AND RECAPTURED LATER ON, IS GIVEN IN PARENTHESIS)

	Months of first capture	Months of last recapture																			
		1963			1964																
		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.
1963																					
April	(16)	2	3	4	—	1	1	1	2	—	—	—	—	—	—	1	—	—	—	1	—
May	(4)		1	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—	1	—	
June	(8)			3	—	1	1	1	—	—	—	—	—	—	—	—	—	—	1	—	
July	(3)				—	—	1	1	2	—	—	—	—	—	—	—	—	—	—	—	
Aug.	(4)				—	—	1	1	1	—	—	—	—	—	1	—	1	—	—	—	
Sept.	(2)					—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	
Oct.	(1)					—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Nov.	(0)						—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Dec.	(0)							—	—	—	—	—	—	—	—	—	—	—	—	—	
1964																					
Jan.	(0)										—	—	—	—	—	—	—	—	—	—	
Feb.	(0)										—	—	—	—	—	—	—	—	—	—	
March	(0)										—	—	—	—	—	—	—	—	—	—	
April	(0)											—	—	—	—	—	—	—	—	—	
May	(3)													—	—	—	2	—	1	—	
June	(4)															—	2	2	—	—	
July	(1)																—	1	—	—	
Aug.	(0)																	—	—	—	
Sept.	(0)																	—	—	—	
Oct.	(0)																	—	—	—	
Nov.	(0)																		—	—	

per cent marked female and one per cent male squirrels persisted in the study area.

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